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L. O. HOWARD, Entomologist and Chief of Bureau.

PAPERS ON DECIDUOUS FRUIT INSECTS
AND INSECTICIDES.

SPRAYING EXPERIMENTS AGAINST
THE GRAPE LEAFHOPPER IN THE
LAKE ERIE ~~VALLEY~~ ~~AREA~~ ~~IN~~ ~~1911~~.

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CONTENTS.

	Page.
Introduction.....	1
Treatment of nymphs of the grape leafhopper with contact sprays.....	1
Field experiments with tobacco extracts.....	2
Vineyard experiments in 1911.....	3
Experiment in vineyard of Mr. H. H. Harper, North East, Pa.....	3
Experiment in vineyard of Mr. W. E. Gray, North East, Pa.....	5
Experiment in vineyard of Mr. J. E. Beatty, North East, Pa.....	7
Experiment in vineyard of Mr. D. C. Bostwick, North East, Pa.....	7
Use of combined contact and poison spray.....	9
Effect of grape leafhopper control on quality of fruit.....	10
Conclusion.....	12

ILLUSTRATIONS.

	Page.
PLATE I. Spraying against the grape leafhopper. Fig. 1.—Rod and single cyclone nozzle used to apply spray to underside of grape foliage. Power supplied by tractor sprayer. Vineyard of Mr. H. H. Harper, North East, Pa. Fig. 2.—Rod carrying two cyclone nozzles used to apply spray to underside of grape foliage. Power supplied by compressed air. Vineyard of Mr. A. I. Loop, North East, Pa.....	4
II. Comparison of sprayed and unsprayed plats. Fig. 1.—Showing condition of vine injured by grape leafhopper in unsprayed plat. Note loss of foliage and also berries from clusters. Vineyard of Mr. W. E. Gray, North East, Pa. Fig. 2.—Showing condition of vine in plat sprayed with tobacco extract No. 1 against grape leafhopper. Note larger size of berries in clusters, heavy foliage, and stronger cane growth. Vineyard of Mr. W. E. Gray, North East, Pa.....	8
III. Spraying against the grape leafhopper. Fig. 1.—Gasoline-engine sprayer supplying power for two "trailer" leads of hose in spraying against grape leafhopper. Vineyard of Mr. J. E. Beatty, North East, Pa. Fig. 2.—Gasoline-engine sprayer supplying power for two "trailer" leads of hose in spraying against grape leafhopper. Vineyard of Peacock-Rood Co., Westfield, N. Y.....	8

TEXT FIGURES.

	Page.
Fig. 1.—The grape leafhopper (<i>Typhlocyba cumea</i> var. <i>coloradensis</i>): Adult....	1
2.—The grape leafhopper: Nymph of the first stage.....	2
3.—The grape leafhopper: Fully developed nymph of the fifth stage.....	2

PAPERS ON DECIDUOUS FRUIT INSECTS AND INSECTICIDES.

SPRAYING EXPERIMENTS AGAINST THE GRAPE LEAFHOPPER IN THE LAKE ERIE VALLEY IN 1911.

By FRED JOHNSON,
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INTRODUCTION.

An insect pest of the grapevine which has increased in abundance and destructiveness in the vineyards of the Lake Erie Valley during the past few years is the grape leafhopper, *Typhlocyba comes* Say (see fig. 1). Preliminary spraying experiments were undertaken against this pest at North East, Pa., by the Bureau of Entomology in 1910. Results of the field work undertaken during that season are presented in Bulletin No. 97, Part I, of the Bureau of Entomology, together with a brief consideration of the characteristics, habits, and life history of the insect, and also the character and extent of its injury to the vine. For this reason the subject matter of this paper deals entirely with experiments conducted during the season of 1911. Readers unfamiliar with the habits of this pest should consult the paper referred to above.



FIG. 1.—The grape leafhopper (*Typhlocyba comes* var. *coloradensis*): Adult. Greatly enlarged. (Author's illustration.)

TREATMENT OF NYMPHS OF THE GRAPE LEAFHOPPER WITH CONTACT SPRAYS.

During the season of 1911 the grape leafhopper was more numerous and destructive to the grapevines in the vineyards of Erie County, Pa., than in 1910. Owing, doubtless, to the higher temperatures prevailing during June and July of this season, the nymphs (see fig. 2) commenced to appear on the leaves at an earlier date, and the development of the nymphal stages of the insect were more rapid than in 1910. Since it is in this the nymphal period before the insect has developed

wings (figs. 2-3) that it is most readily controlled by a contact spray, it was necessary to make the application several days earlier than in the preceding season. In addition to this, the number of days when the maximum number of nymphs was present upon the vines before the earliest to hatch had developed wings was materially lessened,



FIG. 2.—The grape leafhopper: Nymph of the first stage. Greatly enlarged. (Author's illustration.)

thus shortening the period during which the greatest efficiency from the spray applications could be secured. In 1910 the maximum numbers of nymphs of the first brood were present on the underside of the grape leaves about July 15 and spray applications were commenced at that date and were continued until July 26 before many of the nymphs had changed to adults having fully developed wings.

In 1911, however, the maximum numbers of nymphs were present on the leaves by July 5. By July 11 fully 15 per cent of the first nymphs to hatch were changed to the winged form. Thus there was about a week longer time during which the greatest efficiency from the spray application could be secured in the season of 1910 than in 1911. Effective work can be done, however, after many of the nymphs have developed wings, and if the wingless nymphs are still quite numerous upon the leaves the work may be continued with good results. Owing to the more rapid development of the immature stages of the insect in 1911 than in 1910, there was a partial second brood of considerable proportions in 1911, which greatly augmented the injury toward the ripening season. Nevertheless, where vines were thoroughly sprayed against the nymphs of the first brood during the first two weeks in July, only slight injury resulted from the later development of nymphs on these sprayed vines.

FIELD EXPERIMENTS WITH TOBACCO EXTRACTS.

During the summer of 1911 several field experiments, in each case covering several acres, were conducted in vineyards in the township of North East, Pa. In all cases the applications were made against the nymphs about the time the maximum number of the first brood was present on the underside of the grape leaves and before many of the oldest nymphs had changed to the winged form. One thorough application at this time proved sufficient to reduce the

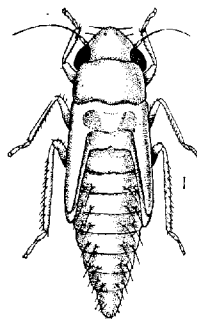


FIG. 3.—The grape leafhopper: Fully developed nymph of the fifth stage. Greatly enlarged. (Author's illustration.)

number of the insects so that those remaining did not materially affect the growth of the vine or the proper ripening of the fruit.

These experiments were conducted in different parts of the township and several types of sprayers were used in making the applications. In all cases the "trailer" method was employed; that is, a trailing hose about 20 feet long was connected to the discharge of the spray pump and a short rod, about 2½ feet long, carrying a large nozzle of the cyclone type set at right angles to the rod was attached to the free end of this lead of hose. This rod is held by the operator, who thrusts the nozzle among the foliage with rapid movements, directing the nozzle upward, so that the liquid is thrown upon the underside of the leaves. (See Pl. I, fig. 1.)

Two forms of commercial tobacco extract were used in these experiments: No. I (blackleaf extract) contained 2.70 per cent nicotine; No. II (blackleaf 40) contained 40 per cent nicotine sulphate. In all of the experiments which follow the tobacco extracts are referred to by number. Tobacco extract No. I refers to the form containing the lower percentage of nicotine, tobacco extract No. II to the form containing the higher percentage of nicotine. At the dilutions used no decided advantage was evidenced in favor of either form of tobacco extract. Both of these substances killed the nymphs that were hit by the spray. The tobacco extract No. I at a dilution of 1 part of extract to 150 parts of water killed all nymphs that were made thoroughly wet by the spray, especially the smaller nymphs, between the first and fourth molts. The full-grown nymphs, unless thoroughly soaked by the spray at this dilution, would sometimes escape, probably because their longer legs held their bodies some distance from the wet surface of the leaf. The tobacco extract No. II was effective at a dilution of 1 part of extract to 1,500 parts of water. In the use of the tobacco extract No. II—as with the tobacco extract No. I, where a large percentage of the nymphs were in the last stage; that is, just about to develop wings (see fig. 3)—a dilution of 1 to 1,200 or 1,300 may be more effective in killing the nymphs. In the several experiments conducted, however, the dilutions varied from 1 to 100 parts of water to 1 to 150 with tobacco extract No. I, and from 1 to 1,000 to 1 to 1,500 with tobacco extract No. II. In all of these variations of dilution apparently equally good results were obtained.

VINEYARD EXPERIMENTS IN 1911.

EXPERIMENT IN VINEYARD OF MR. H. H. HARPER, NORTH EAST, PA.

The east side of the vineyard of Mr. H. H. Harper, North East, Pa., adjoining the highway had been badly infested by the grape leafhopper for several years. Previous to the undertaking of this experiment

the vines had each season made a weaker growth as a result of injury by this pest, and the yield of fruit also was being greatly reduced.

During the season of 1910 several acres on the east side of this vineyard were sprayed with tobacco extract No. I. This treatment resulted in preventing serious injury by the insect. The foliage remained green and healthy throughout the season. There was a greatly increased growth of vine and a higher quality of fruit was secured. The greatest apparent benefit in 1910 was in the great increase in growth of vine.

During the season of 1911 the entire vineyard of 25 acres was sprayed against this pest, which was present in fully as large numbers as in 1910.

A tractor sprayer was used in making the application. (See Pl. I, fig. 1.) A pressure of 100 to 140 pounds was maintained and about 175 gallons of liquid were applied per acre. The application was made by the owner of the vineyard, Mr. H. H. Harper. The spray was applied by the "trailer" method (see Pl. I, fig. 1), using a single large cyclone nozzle. The work was done very carefully and thoroughly. Stops were made at each vine. The pressure was maintained by driving forward the length of the trailer hose. By having a 20-gallon air-chamber on the tractor sprayer a pressure varying from 100 to 140 pounds was secured, rarely dropping below the 100-pound mark. Under favorable working conditions about 3 acres could be covered per day. The tobacco extract No. I was applied at a dilution of 3 quarts to 100 gallons of water. The application was made, on the 3 acres from which our record of yield was secured, on July 6 and 7, when the majority of the nymphs were small but very numerous. The application was very effective, and on account of the thoroughness with which the work was done only a very small percentage of nymphs escaped being killed by the spray.

As a result of this treatment the foliage of the vines remained green throughout the entire season, and the vines made a very heavy growth of new canes. The berries and clusters of fruit were large and of good quality. A record has been kept of the yield for the past three years on 3 acres of this vineyard where the injury by this insect was most apparent at the beginning of the experiment. No attempt to control this pest on these vines was made previous to 1910.

1909.	Yield of fruit was 262 8-pound baskets of grapes per acre.
1910.	Yield of fruit was 423 8-pound baskets of grapes per acre.
1911.	Yield of fruit was 796 8-pound baskets of grapes per acre.

These results show an increase in yield on the first season's treatment of 161 baskets per acre, and for the second season's treatment an increase of 534 baskets per acre over the yield of 1909.

Since the price received per basket of grapes varies each season, it is difficult to compare cash returns one season with another. Prices



FIG. 1.—ROD AND SINGLE CYCLONE NOZZLE USED TO APPLY SPRAY TO UNDERSIDE OF GRAPE FOLIAGE. POWER SUPPLIED BY TRACTOR SPRAYER. VINEYARD OF MR. H. H. HARPER, NORTH EAST, PA. (ORIGINAL.)



FIG. 2.—ROD CARRYING TWO CYCLONE NOZZLES USED TO APPLY SPRAY TO UNDERSIDE OF GRAPE FOLIAGE. POWER SUPPLIED BY COMPRESSED AIR. VINEYARD OF MR. A. I. LOOP, NORTH EAST, PA. (ORIGINAL.)

SPRAYING AGAINST THE GRAPE LEAFHOPPER.

for the past 10 years, however, have averaged about 13 cents per basket. On this basis the cash increase on the treatment in 1910 was \$20.93 per acre, and on the treatment for the second season of 1911 the increase was \$69.42 over that of 1909 before any spray treatment was made against this pest.

The actual cash receipts for the three seasons were as follows:

1909.....	Unsprayed, 11 cents per basket, 262 baskets, \$28.82 per acre.
1910.....	Sprayed, 19 cents per basket, 423 baskets, \$80.37 per acre.
1911.....	Sprayed, 10 cents per basket, 796 baskets, \$79.60 per acre.

Since the actual prices in 1909 and 1911 are almost uniform, the increase in cash return as a result of increased yield is readily seen. This increased cash return in 1911 was \$50.78 per acre.

During these three seasons the general treatment for the vineyard has been the same for each season. The soil was cultivated several times and 420 pounds of fertilizer containing 5 per cent nitrogen, 8 per cent phosphoric acid, and 8 per cent potash were applied each season. A Bordeaux and arsenate of lead spray application, consisting of 4 pounds of copper sulphate, 5 pounds lime, and 3 pounds arsenate of lead to 50 gallons of water, was made just after blossoming. A later application of 1 pound of copper sulphate to 100 gallons of water was made for protection against mildew. Thus the general treatment of the vineyard was good and conducive to the securing of maximum results.

The additional cost of material and labor involved in making the spray application against the grape leafhopper was as follows:

Cost of team per day.....	\$2.25
Boy to drive.....	1.00
Man to handle nozzle.....	1.75
Tobacco extract No. I (strength 3 quarts to 100 gallons of water, applied 175 gallons per acre).....	.85
Cost of material for 3 acres.....	3.36
Total cost of spraying 3 acres per day.....	8.36
Total cost of spraying 1 acre.....	2.79

The power was supplied by a tractor sprayer.

There is no doubt that this tobacco-extract application during the past two seasons has effectively controlled the grape leafhopper and is largely responsible for the increase in crop yield and for the vigorous growth of vine in this vineyard.

EXPERIMENT IN VINEYARD OF MR. W. E. GRAY, NORTH EAST, PA.

The vines in the vineyard of Mr. W. E. Gray, North East, Pa., were badly infested by grape leafhoppers. They were five years old and were bearing a heavy crop of fruit. No spray treatment was given them except with tobacco extract No. I for this pest. About

6 acres were sprayed with tobacco extract No. I. An acre was left unsprayed in the middle of this block.

A gasoline-engine sprayer outfit was used to make the application. The "trailer" method of application was employed.

About 15 per cent of the nymphs of the first brood had developed wings when this spray application was made, July 11 and 12. Nearly all of the nymphs were about full grown and it was thought desirable to use a stronger dilution than in the foregoing experiment. The tobacco extract No. I was used at a dilution of 1 gallon to 100 gallons of water. A pressure of about 125 pounds was maintained throughout. Two leads of hose were used and about 275 gallons of liquid were applied per acre.

Within about three weeks after the application was made the difference in injury on the sprayed and unsprayed grape leaves became noticeable. Upon the unsprayed vines the winged adult "hoppers" were very numerous and the leaves were commencing to turn brown and only a small amount of new growth was being made.

Upon the sprayed vines, on the other hand, the number of winged adults was noticeably much smaller, the foliage was dark green and healthy, and the new growth of vine was quite thrifty throughout the growing season. When the fruit commenced to ripen it became quite evident that the berries and the clusters would be smaller and the fruit not so purple in color upon the unsprayed vines as upon those that were sprayed. Plate II, figure 1, shows a vine in the unsprayed plat. Plate II, figure 2, shows a vine in the sprayed plat. When the crop was harvested the sprayed plat yielded 128 baskets of grapes per acre more than the unsprayed plat. This fruit was sold at 10 cents per basket, giving a gross cash gain of \$12.80 per acre. The cost of spray material and labor of making the application against this pest was as follows:

Team and driver per day.....	\$4.50
Two men to apply spray, \$1.75 per day.....	3.50
Tobacco extract No. I, 275 gallons per acre.....	2.33
Six acres sprayed per day, cost per acre.....	3.66
<hr/>	
Increased cash yield per acre, sprayed plat.....	12.80
Cost of material and application per acre.....	3.66
<hr/>	
Cash increase per acre on sprayed vines.....	9.14

Thus the net yield on the sprayed plat after deducting all expense of labor and material was \$9.14 per acre. In addition to this increase in crop yield the sprayed vines made a more vigorous and healthy growth than did the unsprayed vines, and the fruit was of much better quality.

EXPERIMENT IN VINEYARD OF MR. J. E. BEATTY, NORTH EAST, PA.

The vineyard of Mr. J. E. Beatty, North East, Pa., had been badly infested by grape leafhoppers for several years. As a result of their injury the cane growth of the vines had been greatly reduced and there had been a corresponding reduction in yield of fruit. Thirteen acres of the worst infested sections of this vineyard were sprayed in 1911. Unfortunately, the spraying was not commenced until about 15 per cent of the first nymphs to hatch had changed to the winged form. The application was made July 12 and 14, using a gasoline-engine power-spraying outfit with two "trailer" leads of hose (see Pl. III, fig. 1). A pressure of 175 pounds was maintained and about 250 gallons of liquid were applied per acre. Tobacco extract No. I was used at a dilution of 1 part to 150 parts of water. This dilution gave good results, even though a large percentage of the nymphs was in the last molt. Within about three weeks after the application was made the foliage of the unsprayed vines commenced to turn brown, and as the season advanced new growth at the end of the canes ceased, whereas on the sprayed vines the foliage remained green and the new growth continued to develop until late in the season. The berries were larger and a darker purple in color upon the sprayed vines. When the crop was harvested the fruit from 300 vines in the unsprayed plat and from the same number of vines on the sprayed plat was weighed and showed a gain of 690 pounds from the sprayed plat, thus giving an increase of 1,380 pounds per acre. This fruit was valued at \$0.015 per pound, showing a gross cash gain of \$20.70 per acre. The cost of spray material and labor of application was as follows:

Team and driver per day.....	\$4.50
250 gallons of tobacco extract No. I, diluted spray.....	1.41
Two men handling nozzles.....	3.50
Six acres sprayed per day, cost per acre.....	2.74
Increased cash yield per acre.....	20.70
Cost of material and application.....	2.74
Net cash gain per acre on sprayed vines.....	17.96

EXPERIMENT IN VINEYARD OF MR. D. C. BOSTWICK, NORTH EAST, PA.

The grape leafhopper was very numerous in the vineyard of Mr. D. C. Bostwick, North East, Pa., during the summer of 1911. The experiment was undertaken on a block of young vines in the second year of bearing. The vines in this block were quite uniform and carried a heavy crop of fruit. About 15 per cent of the nymphs had transformed to adults when the spray application was made. The spray was applied from July 13 to 15. Three acres were taken in about the middle of the block. One acre on each side of the untreated

acre was sprayed. The work was done with a tractor vineyard sprayer. This machine had been in use several seasons and was not working at its best. The spray was applied by the "trailer" method. Owing to the poor working of the pump a high pressure was not maintained. The pressure varied anywhere from 150 pounds to 50 pounds. Most of the time it ran below 80 pounds. For this reason it was thought necessary by Mr. Bostwick to make the application on both sides of the trellis. In spite of these drawbacks good results were secured. About 275 gallons of liquid were applied per acre. This is more liquid than would have been applied by this machine had it been in good working condition and, in addition, more time was consumed in making the application on both sides of the row. About 600 gallons of spray were applied per day covering about 2½ acres. Tobacco extract No. II was used at a dilution of 1 to 1,300 parts of water.

Labor cost of application per acre.....	\$2.75
Tobacco extract No. II—1 to 1,300 parts water, per acre.....	2.58
Total cost of labor and material per acre.....	5.33

The net yield of grapes from the three plats was as follows:

One acre of vines east of unsprayed plat.....	8,462 pounds grapes
One acre of vines west of unsprayed plat.....	8,327 pounds grapes
One acre of vines, unsprayed plat.....	7,153 pounds grapes

The cash value of the fruit was \$25 per ton, or \$0.0125 per pound.

Cash value of yield on 1 acre east of check.....	\$105.77
Cash value of yield on 1 acre west of check.....	104.09
Cash value of yield on 1 acre unsprayed.....	89.41
Increased yield on west plat per acre over check was 1,309 pounds, or.....	16.36
Increased yield on west plat per acre over check was 1,174 pounds, or.....	14.67

Net cash gain on sprayed plats after deducting cost of labor and material:

Gross gain on plat west of check per acre.....	\$16.36
Total cost of labor and material per acre.....	5.33
Net gain resulting from spraying per acre.....	11.03
Gross gain on plat east of check per acre.....	14.67
Total cost of labor and material per acre.....	5.33
Net cash gain resulting from spraying per acre.....	9.34

In addition to this increase in weight of fruit yield it was observed that the berries of the grapes were much larger and of better color than was the fruit on the unsprayed vines. It was also observed that the fruit from the sprayed vines gave a greater weight per basket.

507 baskets from the west plat averaged 20.7 pounds per basket.
 497 baskets from the east plat averaged 20.7 pounds per basket.
 478 baskets from the unsprayed plat averaged 19 pounds per basket.



FIG. 1.—SHOWING CONDITION OF VINE INJURED BY THE GRAPE LEAFHOPPER IN THE UNSPRAYED PLAT. NOTE LOSS OF FOLIAGE, AND ALSO THE BERRIES FROM THE CLUSTERS. VINEYARD OF MR. W. E. GRAY, NORTH EAST, PA. (ORIGINAL.)

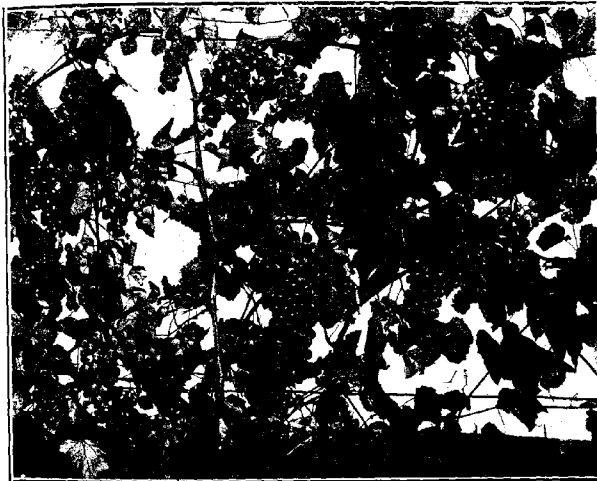


FIG. 2.—SHOWING CONDITION OF VINE IN PLAT SPRAYED WITH TOBACCO EXTRACT NO. 1, AGAINST THE GRAPE LEAFHOPPER. NOTE THE LARGER SIZE OF THE BERRIES IN THE CLUSTERS, HEAVY FOLIAGE AND STRONGER CANE GROWTH. VINEYARD OF MR. W. E. GRAY, NORTH EAST, PA. (ORIGINAL.)

COMPARISON OF SPRAYED AND UNSPRAYED PLATS.



FIG. 1.—GASOLINE-ENGINE SPRAYER SUPPLYING POWER FOR TWO "TRAILER" LEADS OF HOSE, IN SPRAYING AGAINST THE GRAPE LEAFHOPPER. VINEYARD OF MR. J. E. BEATTY, NORTH EAST PA. (ORIGINAL.)



FIG. 2.—GASOLINE-ENGINE SPRAYER SUPPLYING POWER FOR TWO "TRAILER" LEADS OF HOSE IN SPRAYING AGAINST THE GRAPE LEAFHOPPER. VINEYARD OF THE PEACOCK-ROOD COMPANY, WESTFIELD, N. Y. (ORIGINAL.)

SPRAYING AGAINST THE GRAPE LEAFHOPPER.

This shows an average increase in weight of 1.7 pounds per basket for fruit from the sprayed vines. As in the case of all the other experiments, the foliage on the sprayed vines remained green and healthy throughout the season, and new growth of canes continued to be made for a longer period than upon the unsprayed vines.

USE OF COMBINED CONTACT AND POISON SPRAY.

In addition to the experiments described, in which the spray ingredients consisted of either tobacco extract No. I and water or tobacco extract No. II and water, other experiments were made, in one case adding the tobacco extract No. II to Bordeaux mixture and fish-oil soap. In this experiment about two-thirds of an acre of the infested vines was sprayed with the Bordeaux, fish-oil soap, and tobacco extract No. II mixture, and about one-third of an acre was sprayed with tobacco extract No. II and water. So far as could be observed the killing effect of tobacco extract No. II upon the nymphs when mixed with the Bordeaux and soap was in no way lessened; nor was any injurious effect apparent to the leaves and fruit of the vines sprayed with this mixture. The ingredients were used in this mixture at the following dilution: Bordeaux mixture, 3 pounds lime, 3 pounds copper sulphate to 50 gallons of water, plus 2 pounds of fish-oil soap, and tobacco extract No. II at a dilution of 1 to 1,500 parts of the Bordeaux mixture. Tobacco extract No. II at a dilution of 1 to 1,500 parts water.

In another experiment 5 acres of vineyards were sprayed with a mixture of Bordeaux, arsenate of lead, and tobacco extract No. I, at the following dilution, 3 pounds of lime, 3 pounds of copper sulphate, 2 pounds arsenate of lead to 50 gallons of water plus tobacco extract No. I, 1 to 150 parts of the Bordeaux mixture. So far as could be observed the killing effect of the tobacco extract upon the nymphs was not lessened in this mixture nor were any injurious effects from this mixture observed upon the foliage and fruit of the vines. The object of adding the tobacco ingredient to the Bordeaux and the arsenate of lead mixtures is an endeavor to reduce the number of applications made necessary in some instances to control the several insect and fungous enemies attacking the foliage or the fruit of the grapevine. The advisability of applying the tobacco extracts against the grape leafhopper with Bordeaux and arsenate of lead will be a matter for the individual vineyardist to decide after he has made a thorough examination of his vineyard to determine if other insects are present in numbers sufficient to warrant their treatment. The insects which may possibly be infesting the foliage or fruit of the grape at the time of treating the nymphs of the grape leafhopper with the tobacco extracts are the grape rootworm and the grape berry moth.

The second poison application against the grape rootworm to the surface of the leaves of the grape is usually made during the first two

weeks in July. At this time also larvæ of the grapeberry moth are hatching from eggs deposited upon the grape berries. Since it is impossible to cover thoroughly the underside of the grape leaves in spraying for the grape leafhopper without thoroughly wetting the grape clusters it is reasonable to infer that the addition of arsenate of lead would also assist in checking the injury to the grape berries by the larvæ of the grape berry moth. In addition to this the Bordeaux mixture will control the development of mildew on the stems of the grape clusters. The upper surface of the grape leaves also is covered during this process (see Pl. III, fig. 2); hence, if arsenate of lead is present with the tobacco extract this application will control the late emerging beetles of the grape rootworm. As intimated above, the advisability of making this combination of ingredients must be decided by the prevalence and abundance in the vineyard to be treated of the several insects referred to. It should also be borne in mind that this combination treatment is submitted as a suggestion.

The mixing of the tobacco extracts with Bordeaux and arsenate of lead this season was done for the sole purpose of determining if this mixture would be injurious to the grape foliage and berries. As mentioned above, no injurious effect to the vine was observed. Arsenate of lead is the only arsenical that should be used with tobacco extracts, since both arsenite of lime and Paris green cause serious burning of the foliage when mixed with the tobacco extracts.

EFFECT OF GRAPE LEAFHOPPER CONTROL ON QUALITY OF FRUIT

As mentioned in foregoing paragraphs dealing with results secured in these spraying experiments with tobacco extracts, it was observed that in every case where the nymphs were successfully controlled the berries of the grape clusters from these vines were much larger, a darker purple in color, and much sweeter than the fruit from unsprayed vines in the same vineyard. In order to ascertain if there was any marked difference in the sugar content of the grapes from vines growing in the sprayed and unsprayed plots samples representing the average condition of the fruit from sprayed and unsprayed vines from experimental plots in the vineyards of Mr. J. E. Beatty and Mr. W. E. Gray, North East, Pa., were submitted for analysis.

These samples of grapes taken for analysis were forwarded to Prof. Wm. B. Alwood, in charge of Enological Investigations at the laboratory of the Bureau of Chemistry located at Sandusky, Ohio. The samples were there analyzed in connection with the extended studies that Prof. Alwood is making of the chemistry of many varieties of grapes grown in the eastern United States in relation to wine production.

The report received from Prof. Alwood on these samples of grapes from these sprayed and unsprayed experimental plots is given in Table I.

TABLE I. Analysis of grapes from sprayed and unsprayed grapevines in vineyards of Mr. W. E. Gray and Mr. J. E. Beatty, North East, Pa., in experiments with tobacco extract No. 1 against nymphs of grape leafhopper. Analysis made at laboratory of United States Bureau of Chemistry under direction of Prof. Wm. B. Atwood.

Serial No.	Variety, grower, locality.	Field number.	Date collected.	Brix at 20° C.	Specific gravity.	Grams per 100 c. c.				Tartaric acid as tartrates.	Condition of fruit and spray treatment, tobacco extract No. 1.
						Total solids.	Sugar-free solids.	Total sugar as reducing.	Total acid as tartaric.		
3153	Copcori, W. E. Gray, North East, Pa.	123	Sept. 20, 1911	17.7	1.0726	18.84	2.66	16.18	0.720	0.549	Medium bunches, good condition, fully ripe. Vines sprayed against grape leafhopper.
3154	do.	124	do.	11.0	1.0445	11.52	2.91	8.61	.908	.612	Bunches small, berries small, poor condition, oddish against grape leafhopper. Vines not sprayed against grape leafhopper.
3155	J. E. Beatty, North East, Pa.	125	Sept. 21, 1911	18.7	1.0777	20.18	3.00	17.18	.720	.540	Fine bunches, grapes large and in good condition, fully ripe. Vines sprayed against grape leafhopper.
3156	do.	126	do.	14.5	1.0576	14.93	2.41	12.52	.720	.583	Bunches fair, small uneven berries, poor quality, fully ripe. Vines not sprayed against grape leafhopper.
3261	W. E. Gray, North East, Pa.	236	Oct. 11, 1911	18.4	1.0772	20.05	1.71	18.34	.450	.369	Bunches large, good condition, fully ripe. Vines sprayed against grape leafhopper.
3290	do.	235	do.	13.1	1.0534	13.83	1.86	11.97	.536	.404	Bunches and berries small, poor sample. Vines not sprayed against grape leafhopper.

In comparing the sugar content of the samples from the sprayed and the unsprayed plats it will be observed that the sample from the unsprayed plat under serial No. 3154 showed a sugar content of only 8.61 grams per 100 c. c. as against 16.18 grams per 100 c. c. for sample 3153 from the sprayed plat. In other words, the sample of grapes taken from the plat where the injury to the foliage of the vines by the grape leafhopper was unchecked, by withholding the tobacco-extract spray against the nymphs, contained only about one-half the sugar content that was present in the sample taken from the vines which were sprayed with the tobacco against this insect in the nymphal stage. Samples under serial No. 3156 from the unsprayed plat show a sugar content of 4.66 grams per 100 c. c. less than sample No. 3155, taken from the sprayed plat, and sample No. 3260 from unsprayed plat shows a sugar content of 6.37 grams per 100 c. c. less than sample 3261, taken from sprayed vines in the same vineyard.

In answer to an inquiry as to the approximate difference in value of the fruit from these sprayed and unsprayed plats for use in making wine or grape juice Prof. Alwood gives the following reply:

In response to your question I may say that the sugar content of the three untreated plats is so low that they would have no value whatever for making pure wine or unfermented grape juice and could only be used for some low grade sophisticated products.

Thus the analysis of these samples of fruit indicates that serious injury to the foliage of the grapevine by the grape leafhopper greatly impairs the quality of the fruit. A definite knowledge of this fact furnishes an additional reason why the vineyardist should resort to every practical means at his disposal for the control of this insect whenever it is at all numerous in his vineyard.

CONCLUSION.

The field experiments made during the season of 1911 against the grape leafhopper and recorded in this paper show that a single application of the tobacco extracts applied against this insect in the nymphal stage as a contact spray will reduce its numbers to such an extent that the infested vines will remain in good foliage throughout the season and mature a crop of high-quality fruit.

As indicated by the variation in the time and rapidity in development of the nymphs in 1910 and 1911, it is evident that no definite date for making the spray application can be given. Where the winged adults are at all numerous in the early part of the season the vineyardist is urged to examine the underside of the grape leaves toward the middle and the end of June and to observe the number and size of the nymphs. The spray application to be most effective should be made at about the time the first nymphs to hatch are near the last molt. This is indicated by the length of the wing pads.

(See fig. 3.) At this time the underside of badly infested leaves will be covered by the nymphs in all stages of development. Generally speaking, this condition is likely to occur in the Lake Erie Valley from July 1 to 15. All of the field experiments conducted in 1910 and 1911 were made between these dates and in every instance very satisfactory results were secured. Since the nymphs continue to hatch over a long period, if the spray application is made while the first nymphs to hatch are quite small large numbers are likely to hatch after the spray application has been made, thus necessitating a second application a few weeks later. On the other hand, if the application is withheld until many of the nymphs have developed wings it is doubtful if large vineyard areas can be treated before a large percentage of the nymphs have reached the winged stage. For it must be understood that the tobacco extracts at the dilutions recommended are effective only against the wingless nymphs infesting the underside of the grape foliage. Where it is necessary to treat large areas for this pest, observation would indicate that spray applications should commence during the first week in July.

Observations on the abundance and the extent of injury wrought by this insect pest of the grapevine in the vineyard areas of New York, Pennsylvania, and Ohio bordering on Lake Erie, and also in the vineyard areas of Michigan, indicate that its depredations have increased during the past few years. Progressive vineyardists are commencing to realize that the accumulated injury to the vines by this pest is responsible for curtailment in crop yield and inferiority in quality of fruit wherever it is present on grapevines in large numbers and that steps must be taken to accomplish its control. It is for this reason that the experiments presented in this paper were undertaken, and it is hoped that the results obtained are of sufficient commercial value to encourage grape growers having vineyard areas infested by the grape leafhopper to adopt this method of control.

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